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RESEARCH ARTICLE

BRIDELIA FERRUGINEA BARK: PHYTOCHEMICAL ANALYSIS AND BIOACTIVITY ASSESSMENT FOR POTENTIAL THERAPEUTIC APPLICATIONS

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ABSTRACT

Bridelia ferruginea bark is investigated for its phytochemical composition and bioactivity to explore its therapeutic potential. The phytochemical analysis reveals significant quantities of alkaloids (62.95 mg/g), saponins (64.31 mg/g), flavonoids (100.19 mg/g), tannins (78.08 mg/g), and phenols (253.62 mg/g). The nitrogen-free extract dominates at 53.23%, followed by crude fiber at 24.44%. Additionally, the moisture, crude protein, crude fat, and ash content in *Bridelia ferruginea* bark powder are reported at 7.63%, 2.15%, 8.72%, and 3.83%, respectively. Assessment of bioactivity indicates a lipid inhibition percentage of 23.88% and a vitamin C content of 55.97%. Moreover, the bark exhibits Fe chelation (13.44%) and DPPH radical scavenging activity (83.54%). Furthermore, it demonstrates inhibition of albumin denaturation (62.71%) and antiproteinase activity (69.534%). Importantly, it shows promising α-amylase inhibition (37.60%) and α-glucosidase inhibition (58.07%). These diverse bioactivities suggest potential applications in pharmaceuticals and nutraceuticals, warranting further studies for formulation development targeting both human and animal health. *Bridelia ferruginea* bark emerges as a valuable natural resource with multifaceted therapeutic prospects, inviting extensive exploration for practical utilization.

KEYWORDS

Bridelia ferruginea, Phytochemical analysis, Bioactivity assessment, Therapeutic potential, Pharmaceutical and nutraceutical applications.

1. INTRODUCTION

Growing interest in using the health-promoting qualities of substances originating from plants has led to the development of a new field at the intersection of pharmacology and nutrition: the use of phytogens or phytochemicals as nutraceutic food or feed supplements (Oloruntola et al., 2024). The focus on preventive healthcare and holistic wellness has led to a paradigm change in the use of foods and supplements high in phytochemicals in diet plans to support optimal health and reduce the risk of chronic illnesses (Santa et al., 2023). Phytochemicals, which range from flavonoids and phenolic compounds to carotenoids and polyphenols, have a wide range of bioactivities, such as anti-inflammatory, antibacterial, anticancer, cardioprotective, neuroprotective, and immune-boosting qualities (Sun and Shahrajabian, 2023). Their capability to preserve homeostasis and fight oxidative stress, inflammation, and other pathological situations is further demonstrated by their capacity to modify a variety of cellular signalling pathways and metabolic processes (Tungmunnithum et al., 2018). Therefore, research into phytogens as nutraceutic food supplements has potential to improve dietary intake, promote general health and wellbeing, and possibly lessen the prevalence of non-communicable diseases in modern society (Alissa and Ferns, 2012).

A plant species native to tropical and subtropical areas, *Bridelia ferruginea* has long been valued for its therapeutic qualities in a variety of traditional medical systems and cultures (Yeboah et al., 2022). *Bridelia ferruginea* bark is a promising candidate in the search for novel therapeutic agents (Yeboah et al., 2022). This has led to scientific investigation into the phytochemical composition and bioactivity of the bark to clarify its possible uses in pharmaceuticals and nutraceuticals.

The primary aim of this study is to undertake a comprehensive phytochemical analysis of *Bridelia ferruginea* bark, focusing on identifying and quantifying its bioactive constituents to elucidate its chemical profile. Through investigating a spectrum of pharmacological activities, including antioxidant, anti-inflammatory, analgesic, and antidiabetic properties, this study seeks to delineate the mechanisms underlying the observed bioactivities, thereby providing insights into its therapeutic potential.

2. MATERIALS AND METHODS

2.1. *Bridelia ferruginea* bark collection and processing

On the premises of The Federal Polytechnic, Ado Ekiti, Nigeria, the mother plants were harvested for the bark of *Bridelia ferruginea*. The bark was divided into small pieces, distributed thinly, and allowed to dry for thirty days under a shed. Next, it was ground into a powder using a 0.5 mm screened hammer mill and stored in a plastic container in the freezer until it was needed for laboratory examination. Three determinations of each index were made.

2.2. Phytochemical and proximate components of powdered *B. ferruginea* bark

The quantity of alkaloids, saponins, flavonoids, tannins, and phenol were all measured in the powdered bark of *Bridelia ferruginea* (Adeniyi et al.,

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2009; He et al., 2014; Surana et al., 2016; Biswas et al., 2020; Otles and Yalcin, 2012). According to the protocol previously described a researcher in 2021 (Oloruntola, 2021). While the proximate composition of the powdered *B. ferruginea* bark was determined according to AOAC (2010).

2.3. The antioxidant and anti-inflammatory properties of powdered *B. ferruginea* bark

Antioxidant indices and anti-inflammatory parameters were assessed in this study. Lipid peroxidation inhibition, vitamin C content, Fe chelation capacity, and scavenging activity against 2-diphenyl-1-picryl-hydrazyl-hydrate radicals were determined (Bajpai et al., 2015; Benderitter et al., 1998; Chew et al., 2009; Otles and Yalcin, 2012). Additionally, anti-inflammatory properties were evaluated through albumin denaturation inhibition, anti-proteinase activity (Osman et al., 2016; Rajesh et al., 2019). The methodologies for assessing the antioxidant and anti-inflammatory effects of *Bridelia ferruginea* bark have been extensively detailed in previous publications (Chai et al., 2014; Oloruntola and Ayodele, 2022; Oloruntola et al., 2021; Oloruntola et al., 2023).

2.4. The anti-diabetic properties of powdered *Bridelia ferruginea* bark

The inhibitory activities of α-amylase and α-glucosidase were ascertained by utilising the procedures documented (Wickramaratne et al., 2016; Dejadisai and Pitakbut, 2015; Oloruntola and Ayodele, 2022).

3. Results And Discussion

Figure 1 displays the comprehensive phytochemical composition of *Bridelia ferruginea* bark powder. The phytochemical analysis reveals notable quantities of various compounds, including alkaloids (62.95 mg/g), saponins (64.31 mg/g), flavonoids (100.19 mg/g), tannins (78.08 mg/g), and phenols (253.62 mg/g).

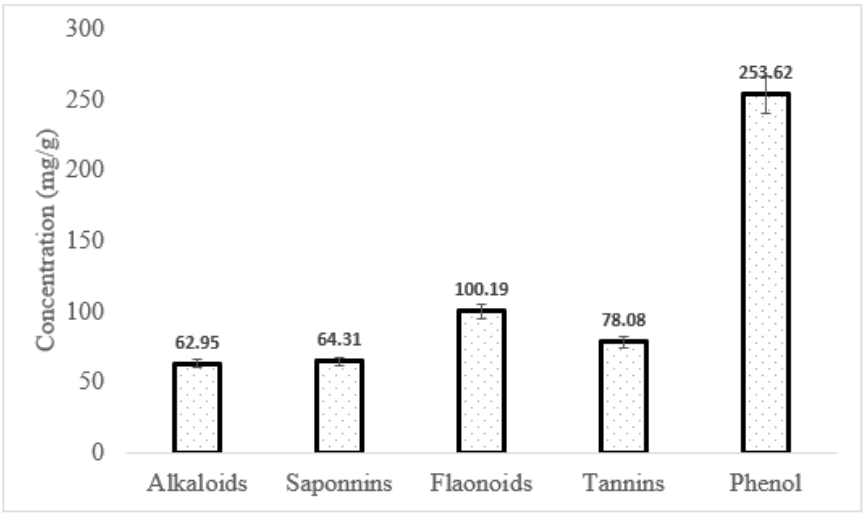

Figure 1: Phytochemical composition of *Bridelia ferruginea* bark powder

The phytochemical composition of *Bridelia ferruginea* bark powder, as revealed by the analysis, underscores its potential nutraceutical, pharmaceutical, and nutritional functions as a feed or food supplement. Each phytochemical constituent contributes to its overall bioactivity and therapeutic potential. Alkaloids, present at a concentration of 62.95 mg/g, are known for their diverse pharmacological effects, including analgesic, anti-inflammatory, and antimicrobial properties (Souto et al., 2011; Yeboah et al., 2022). These compounds could contribute to the pain-relieving and anti-inflammatory effects of *Bridelia ferruginea* bark powder, making it beneficial for alleviating discomfort and combating infections in both human and animal health.

Saponins, with a concentration of 64.31 mg/g, possess cholesterol-lowering, immune-modulating, and anticancer properties (Shi et al., 2004). As natural surfactants, saponins can aid in emulsification and digestion, potentially enhancing the bioavailability of nutrients in the gastrointestinal tract (Schreiner et al., 2022). Additionally, their immunomodulatory effects may support immune function, while their cholesterol-lowering properties could contribute to cardiovascular health (Shen et al., 2024). Flavonoids, present at 100.19 mg/g, exhibit antioxidant, anti-inflammatory, and antiviral activities. These compounds play a crucial role in neutralizing free radicals, thereby reducing oxidative stress and inflammation (Al-Khayri et al., 2022). Flavonoids also have potential antiviral effects, which could be beneficial for combating viral infections in both humans and animals (Ninfali et al., 2020). Tannins, with a concentration of 78.08 mg/g, possess antioxidant, antimicrobial, and astringent properties. These compounds can scavenge free radicals, inhibit microbial growth, and promote wound healing through their astringent effects (Orlowski et al., 2018). Tannins may also contribute to the preservation of feed or food products by inhibiting microbial spoilage (Vera et al., 2023). Phenols, present at 253.62 mg/g, are potent antioxidants with antimicrobial and anti-inflammatory properties. These compounds can protect cells from oxidative damage, inhibit microbial growth, and reduce inflammation. Phenols may also contribute to the preservation of feed or food products by inhibiting oxidation and microbial spoilage (Rahman et al., 2021).

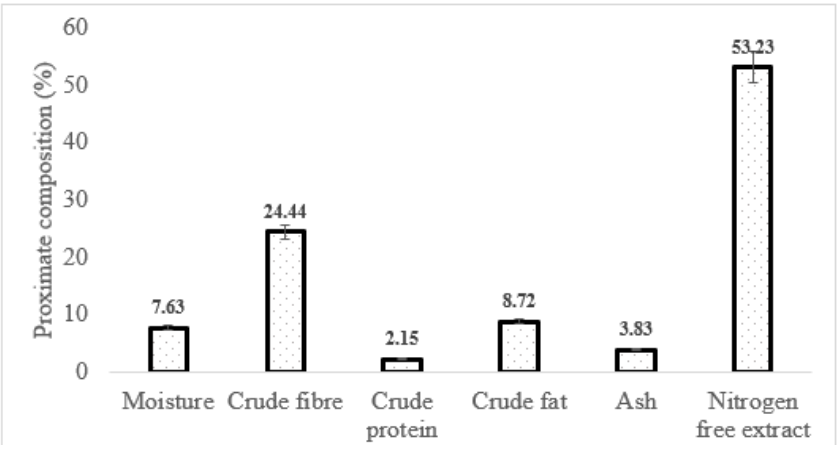

Figure 2: Proximate composition of *Bridelia ferruginea* bark powder

Figure 2 depicts the proximate composition of *Bridelia ferruginea* bark powder. The nitrogen-free extract exhibits the highest composition at 53.23%, followed by crude fiber at 24.44%. The concentrations of moisture, crude protein, crude fat, and ash in *Bridelia ferruginea* bark powder were reported at 7.63%, 2.15%, 8.72%, and 3.83%, respectively. The compositional analysis of *Bridelia ferruginea* bark powder reveals valuable insights into its nutritional and nutraceutical potential, shedding light on its suitability as a nutraceutical supplement. The high proportion of nitrogen-free extract (53.23%) indicates a substantial carbohydrate content, suggesting that *Bridelia ferruginea* bark powder could serve as a significant energy source. Carbohydrates are essential macronutrients that provide energy for various physiological functions and activities. Additionally, the presence of crude fiber (24.44%) suggests a significant dietary fiber content, which is beneficial for digestive health, promoting regular bowel movements, and reducing the risk of gastrointestinal disorders (Gill et al., 2021). Dietary fiber also plays a role in controlling blood sugar levels and cholesterol levels, thereby contributing to overall cardiovascular health (Saboo et al., 2022). Moreover, the moderate levels of moisture (7.63%) and ash (3.83%) indicate the presence of essential minerals and water content, which are crucial for maintaining hydration and electrolyte balance in the body. These minerals play vital roles in various physiological processes, including nerve function, muscle contraction, and bone health. In comparison to similar phytogens or phytochemicals, the proximate composition of *Bridelia ferruginea* bark powder exhibits notable similarities and differences. For instance, other botanicals rich in carbohydrates and dietary fiber, such as psyllium husk or oat bran, share similar nutritional profiles, highlighting the potential of *Bridelia ferruginea* bark powder as a dietary fiber supplement (Khalid et al., 2022). Additionally, the presence of protein (2.15%) and fat (8.72%) in *Bridelia ferruginea* bark powder suggests a modest but noteworthy contribution to overall macronutrient intake. Furthermore, the proximate composition of *Bridelia ferruginea* bark powder underscores its potential as a nutraceutical supplement. Its rich carbohydrate and dietary fiber content, coupled with moderate levels of protein and fat, position it as a functional food ingredient with potential health benefits.

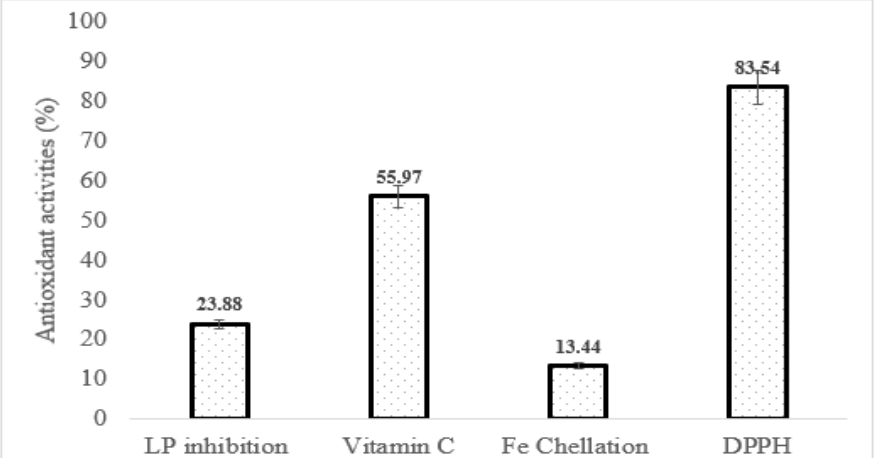

Figure 3: Anti-oxidant properties of *Bridelia ferruginea* bark powder.

Figure 3 presents the antioxidant properties of *Bridelia ferruginea* bark powder. The lipid inhibition percentage and vitamin C content were recorded as 23.88% and 55.97%, respectively, while the Fe chelation and DPPH values were determined as 13.44% and 83.54%, respectively. The antioxidant properties of *Bridelia ferruginea* bark powder, as demonstrated by the levels of lipid inhibition percentage, vitamin C, Fe chelation, and DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity, play a crucial role in determining its nutritional and nutraceutical value, as well as its suitability as a nutraceutical supplement. The lipid inhibition percentage, indicating the ability of *Bridelia ferruginea* bark powder to inhibit lipid oxidation, is a key indicator of its potential in preserving food products and preventing rancidity (Shahidi and Hossain, 2022). Lipid oxidation is a major cause of deterioration in food quality, leading to off-flavors and loss of nutritional value (Shahidi and Hossain, 2022). The observed lipid inhibition percentage of 23.88% suggests that *Bridelia ferruginea* bark powder possesses significant antioxidant activity, which can help extend the shelf life of food products and maintain their nutritional integrity. Vitamin C, a well-known antioxidant, plays a vital role in scavenging free radicals and protecting cells from oxidative damage (Carr and Maggini, 2017). The presence of vitamin C in *Bridelia ferruginea* bark powder, with a content of 55.97%, underscores its antioxidant potential and its ability to contribute to overall health and well-being. Vitamin C is essential for collagen synthesis, immune function, and wound healing, making it a valuable nutrient in maintaining skin health, supporting the immune system, and promoting tissue repair (Carr and Maggini, 2017). Furthermore, the Fe chelation activity of *Bridelia ferruginea* bark powder (13.44%) suggests its ability to chelate or bind with iron ions, thereby inhibiting their participation in oxidation reactions and reducing the formation of harmful free radicals. This property is particularly relevant in preventing oxidative stress-related diseases and mitigating the risk of iron-induced lipid peroxidation (Sudan et al., 2014). Moreover, the high DPPH radical scavenging activity of *Bridelia ferruginea* bark powder (83.54%) indicates its potent ability to neutralize free radicals and protect cells from oxidative damage. DPPH is a stable free radical widely used to assess the antioxidant capacity of natural compounds (Rahman et al., 2015). The observed DPPH radical scavenging activity suggests that *Bridelia ferruginea* bark powder possesses strong antioxidant potential, which can confer various health benefits, including reducing the risk of chronic diseases and promoting overall well-being. The antioxidant properties of *Bridelia ferruginea* bark powder, as evidenced by its lipid inhibition percentage, vitamin C content, Fe chelation, and DPPH radical scavenging activity, underscore its potential as a valuable nutraceutical supplement. Its potent antioxidant activity can contribute to combating oxidative stress, reducing the risk of chronic diseases, and promoting overall health and well-being.

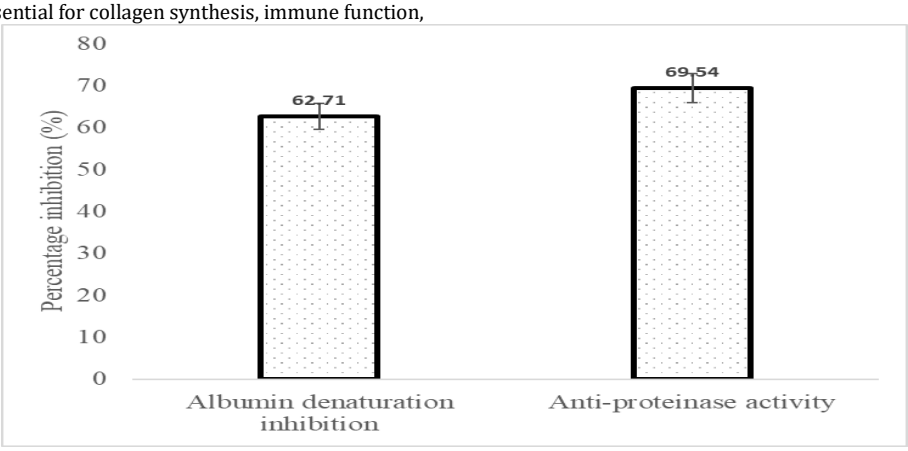

Figure 4: Anti-inflammatory properties of *Bridelia ferruginea* bark powder

Figure 4 illustrates the anti-inflammatory properties of *Bridelia ferruginea* bark powder. The inhibition of albumin denaturation and antiproteinase activity of *Bridelia ferruginea* bark powder were determined to be 62.71% and 69.534%, respectively. The anti-inflammatory properties of *Bridelia ferruginea* bark powder, as evidenced by its inhibition of albumin denaturation and antiproteinase activity, are significant indicators of its nutritional and nutraceutical value, as well as its suitability as a nutraceutical supplement. The inhibition of albumin denaturation is a crucial parameter in assessing the anti-inflammatory potential of natural compounds. Denaturation of albumin, a major protein in the body, is associated with various inflammatory conditions and can lead to tissue damage and dysfunction (Hasan et al., 2023). The observed inhibition of albumin denaturation by *Bridelia ferruginea* bark powder (62.71%) suggests its ability to mitigate inflammatory processes and protect against tissue damage. This anti-inflammatory activity is essential for maintaining tissue integrity, reducing pain and swelling, and promoting overall tissue healing. Similarly, the antiproteinase activity of *Bridelia ferruginea* bark powder (69.534%) indicates its ability to inhibit proteolytic enzymes involved in inflammatory pathways. Proteolytic enzymes, such as proteases, are implicated in the breakdown of connective tissue and the exacerbation of inflammatory responses (Pandey et al., 2017). By inhibiting these enzymes, *Bridelia ferruginea* bark powder can attenuate inflammatory cascades, prevent tissue degradation, and alleviate inflammatory conditions. This antiproteinase activity is particularly relevant in conditions characterized by excessive protease activity, such as arthritis, asthma, and inflammatory bowel diseases. In comparison to similar phytogens or phytochemicals, the inhibition of albumin denaturation and antiproteinase activity by *Bridelia ferruginea* bark powder highlights its potential as a potent anti-inflammatory agent. Other botanicals known for their anti-inflammatory properties, such as turmeric (*Curcuma longa*) or ginger (*Zingiber officinale*), exhibit comparable or even lower inhibitory effects on albumin denaturation and antiproteinase activity (Zhou et al., 2022), underscoring the promising anti-inflammatory potential of *Bridelia ferruginea* bark powder. Overall, the inhibition of albumin denaturation and antiproteinase activity by *Bridelia ferruginea* bark powder reflects its potential as a valuable nutraceutical supplement with anti-inflammatory properties. Its ability to modulate inflammatory processes, protect against tissue damage, and alleviate inflammatory conditions highlights its therapeutic potential in promoting overall health and well-being. Further research into its bioactive constituents and mechanisms of action is warranted to fully elucidate its anti-inflammatory efficacy and optimize its use as a nutraceutical supplement.

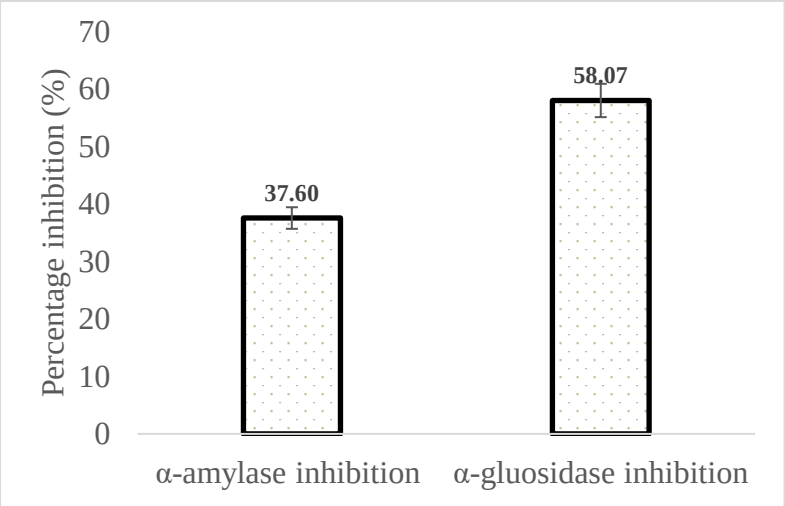

Figure 5: Anti-diabetic properties of *Bridelia ferruginea* bark powder

Figure 5 illustrates the anti-diabetic properties of *Bridelia ferruginea* bark powder. The α-amylase inhibition and α-glucosidase inhibition were determined to be 37.60% and 58.07%, respectively.

The α-amylase inhibition and α-glucosidase inhibition properties exhibited by *Bridelia ferruginea* bark powder hold significant implications for its nutritional and nutraceutical values, as well as its suitability as a nutraceutical supplement, particularly in the management of diabetes and related metabolic disorders. The α-amylase and α-glucosidase are key enzymes involved in the breakdown of complex carbohydrates into simple sugars during digestion (Alqahtani et al., 2019). Inhibiting these enzymes can lead to a decrease in the rate of carbohydrate digestion and absorption, thereby reducing postprandial glucose levels and improving glycemic control (Alqahtani et al., 2019). This mechanism is particularly relevant for individuals with diabetes, as it helps regulate blood sugar levels and may reduce the risk of hyperglycemia-related complications (Kashtoh and Baek, 2022). The α-amylase inhibition property of *Bridelia ferruginea* bark powder, with a percentage inhibition of 37.60%, suggests its ability to interfere with the breakdown of starch into glucose in the digestive tract. By inhibiting α-amylase activity, *Bridelia ferruginea* bark powder may slow down the rate of carbohydrate digestion, resulting in a more gradual release of glucose into the bloodstream. This can help prevent rapid spikes in blood sugar levels following meals, making it beneficial for individuals with diabetes or those at risk of developing diabetes. Similarly, the α-glucosidase inhibition property of *Bridelia ferruginea* bark powder, with a percentage inhibition of 58.07%, indicates its ability to impede the conversion of complex carbohydrates into glucose in the small intestine (Oyebode et al., 2022). By inhibiting α-glucosidase activity, *Bridelia ferruginea* bark powder may further delay the absorption of glucose, leading to more stable blood sugar levels postprandially (Ansari et al., 2022). Some botanicals known for their anti-diabetic properties, such as bitter melon (*Momordica charantia*) or fenugreek (*Trigonella foenum-graecum*), exhibit comparable inhibitory effects on α-amylase and α-glucosidase activity (Ota and Ulrih, 2017). Underscoring the promising anti-diabetic potential of *Bridelia ferruginea* bark powder.

5. Conclusion

Bridelia ferruginea bark powder exhibits diverse bioactivities, suggesting therapeutic potential in pharmaceuticals and nutraceuticals. Therefore, studies should be carried out to explore formulation for human and animal health applications.

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